

I. Rejection Under 35 U.S.C. §112, First Paragraph

Claims 1 and 13 are rejected under 35 U.S.C. § 112 as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors at the time the application was filed, had possession of the claimed invention. Claim 1 has been cancelled. Claim 13 has been amended, is supported by the specification, and no longer contains the language to which the Examiner objected. Applicants therefore respectfully request that the Examiner withdrawn the rejection with respect to claim 13.

II. Rejection Under 35 U.S.C. §112, Second Paragraph

The Examiner rejected claims 13, 22, 25, 26, 28, 29, 30, and 34 as failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Claims 13, 22, 25, 26, 28, 29, 30, and 34 have been amended, are supported by the specification, and no longer contain the language to which the Examiner objected. Applicants therefore respectfully request that the Examiner withdrawn the rejection with respect to claims 13, 22, 25, 26, 28, 29, 30, and 34.

III. Rejection Under 35 U.S.C. §102

The Examiner rejected claims 1, 2, 4-7, 9, 35-41, 13-15, 18, and 25-33 under 35 U.S.C. § 102(b) as anticipated by *Yoo* (U.S. Patent No. 5,670,423). Claims 1, 2, 4-7, 9 have been cancelled.

Claim 10 recites the limitation of “providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.” As stated by the Examiner, *Yoo* fails to teach such a limitation (page 4, 3rd paragraph of Office Action). *Yoo* therefore cannot anticipate claim 10. Claims 36-40 have been amended to depend from claim 10, and therefore cannot be anticipated by *Yoo*.

Claim 13 has also been amended to recite the limitation of “providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.” As discussed with regard to claim 10, *Yoo* does not teach such a limitation. Claim 13 is therefore

not anticipated by *Yoo*. As claim 13 is not anticipated, neither are claims 14, 15, 18, and 35 anticipated, as these claims depend from claim 13.

Claims 25, 26, 28, 29, 30, and 32 have been amended to recite the limitation of “providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.” As stated above, this limitation is not disclosed by *Yoo*. As such, *Yoo* can not anticipate claims 25, 26, 28, 29, 30, and 32, nor claims 27, 31, and 33, which depend from these claims. Applicants therefore respectfully request that the rejection with respect to claims 35-41, 13-15, 18, and 25-33 be withdrawn.

IV. Rejection Under 35 U.S.C. §103

The Examiner has rejected claims 3, 8, 10-12, 16, 17, 19, 20-24, and 34 under 35 U.S.C. 103(a) as being unpatentable over *Yoo* as applied to claims 1, 13, and 30 above and further in view of *Followan* (US 5,176,792). Claims 3 and 8 have been cancelled.

Claim 10 recites, and claims 13, 22, and 34 have been amended to recite, the limitation of “providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.” As stated above and pointed out by the Examiner, *Yoo* does not teach or suggest such a limitation.

The Examiner stated that, since “*Followan* etches a titanium mask with a fluorine plasma and within the same temperature range as that of the present invention and Specification”, then “using *Followan*’s etching method would inherently provide energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.” Applicants respectfully disagree with the Examiner’s statement. First, *Followan* does not provide energy to the reactor. Second, *Followan* limits the temperature of the reactor (col. 1, lines 60-64) to under 200 degrees C. *Followan* does not provide energy by increasing the temperature of the reactor, but instead limits the temperature of the reactor. Third, *Followan* does not attempt to slow down the rate of erosion of the hard mask. On the contrary, *Followan* deposits titanium etched from the hard mask on the sidewalls in order

to obtain vertical sidewalls and virtually no undercut (col. 3, lines 4-11). *Followan* therefore teaches away from “providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask,” as *Followan* takes advantage of hard mask erosion and would not obtain the same favorable results if hard mask etch were slowed. As *Followan* does not teach such a limitation, and in fact teaches away from such a limitation, *Followan* cannot render claims 10, 13, 22, and 34 obvious. Neither is such a limitation taught or suggested by *Yoo* and *Followan* in combination, as the combination still would teach away from providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask. As such, claims 10, 13, 22, and 34 cannot be rendered obvious by *Yoo* and *Followan*, either alone or in combination. Claims 11-12, 16, 17, 19, 20-21, and 23-24 depend from these claims and similarly cannot be rendered obvious by *Yoo* and *Followan*. Applicants therefore respectfully request that the rejection with respect to claims 10-12, 16, 17, 19, 20-24, and 34 be withdrawn.

V. Newly Added Claims

Claims 42-49 have been added in order to allow the limitations of cancelled claims 2-9 to depend from claim 10. These new claims therefore do not add new matter to the application and should be in condition for allowance.

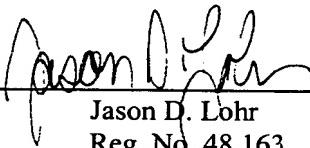
VI. Conclusion

In light of the above, it is respectfully submitted that all of the claims now pending in the subject patent application should be allowable, and a Notice of Allowance is requested. The Examiner is respectfully requested to telephone the undersigned before an advisory action is issued in order to avoid any unnecessary filing of an appeal.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

Date: 5/7/02

By: 
Jason D. Lohr
Reg. No. 48,163

FLIESLER DUBB MEYER & LOVEJOY LLP
Four Embarcadero Center, Fourth Floor
San Francisco, California 94111-4156
Telephone: (415) 362-3800

APPENDIX

In the Claims:

12. (Once Amended) The method of claim [1] 10 including the step of:
oxidizing the hard mask either prior to or during the processing step.
13. (Thrice Amended) A method for etching a pattern on a workpiece including the steps of:
[A method for minimizing growth of the width of features etched from a layer on a workpiece including
the steps of:]
selecting a workpiece with a hard mask deposited over a layer to be etched, wherein said hard
mask has [a low sputter yield and] a low reactivity to the etch chemistry of an etch process; [and]
processing the workpiece in a reactor using the said etch chemistry in order to etch the layer and
exposing the hard mask to the etch chemistry; and
providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order
to slow down the rate of erosion of the hard mask.
[whereby features are created under the hard mask from the etch of the layer, the hard mask
providing for minimal growth of the width of the features beyond the hard mask.]
22. (Twice Amended) A method for etching a pattern on a workpiece including the steps of:
[A method for minimizing growth of the width of features etched from a layer on a workpiece including
the steps of:]
selecting a workpiece with a hard mask deposited over a layer to be etched, wherein said hard
mask has a low sputter yield and a low reactivity to the etch chemistry of an etch process;
processing the workpiece in a reactor using the said etch chemistry in order to etch the layer and
exposing the hard mask to the etch chemistry; and

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

25. (Thrice Amended) A method for etching a pattern on a workpiece including the steps of:
[A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:]

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of at least one of titanium, titanium compounds, aluminum, aluminum compounds, tantalum, tantalum compounds, tungsten, tungsten compounds, cobalt, cobalt compounds, molybdenum, and molybdenum compounds; [and]

processing the workpiece in the reactor using an etch step and exposing the hard mask to the etch step; and [.]

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

26. (Thrice Amended) A method for etching a pattern on a workpiece including the steps of:
[A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:]

depositing on a substrate workpiece and over a layer to be etched a hard mask comprising at least one of a reactive metal, an oxide of a reactive metal, a nitride of a reactive metal, a fluoride of a reactive metal, a boride of a reactive metal, and a carbide of a reactive metal; [and]

processing the workpiece in the reactor using an etch step and exposing the hard mask to the etch step; and [.]

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

28. (Thrice Amended) A method for etching a pattern on a workpiece including the steps of:

[A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:]

depositing on a workpiece and over a layer to be etched a hard mask, wherein said hard mask has at least one of a low sputter yield and a low reactivity to the etch chemistry of an etch process; [and]

processing the workpiece in the reactor using the said etch chemistry in order to etch the layer and exposing the hard mask to the etch chemistry; and [.]

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

29. (Thrice Amended) A method for etching a pattern on a workpiece including the steps of:

[A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:]

depositing on a workpiece and over a layer to be etched, a hard mask which comprises at least one of titanium, titanium compounds, aluminum, aluminum compounds, tantalum, tantalum compounds, tungsten, tungsten compounds, cobalt, cobalt compounds, molybdenum, and molybdenum compounds; [and]

processing the workpiece in the reactor using an etch step and exposing the hard mask to the etch step; and [.]

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

30. (Thrice Amended) A method for etching a pattern on a workpiece including the steps of:

[A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:]

selecting a workpiece with a hard mask consisting of one of a reactive metal, an oxide of a reactive metal, a nitride of a reactive metal, a fluoride of a reactive metal, a boride of a reactive metal, and a carbide of a reactive metal, and a compound comprising any combination of an oxide, a fluoride, a nitride, a carbide, and a boride of a reactive metal, deposited over a layer to be etched; [and]

processing the workpiece in the reactor using an etch step and exposing the hard mask to the etch step; and [.]

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

34. (Twice Amended) A method for etching a pattern on a workpiece including the steps of: [A method for minimizing growth of the width of features etched from a layer on a workpiece including the steps of:]

selecting a workpiece with a hard mask consisting of one of a reactive metal, an oxide of a reactive metal, a nitride of a reactive metal, a fluoride of a reactive metal, a boride of a reactive metal, and a carbide of a reactive metal, and a compound comprising any combination of an oxide, a fluoride, a nitride, a carbide, and a boride of a reactive metal, deposited over a layer to be etched;

processing the workpiece in the reactor using an etch step and exposing the hard mask to the etch step; and

providing energy to the reactor in order to increase a rate of oxidation of the hard mask in order to slow down the rate of erosion of the hard mask.

36. (Once Amended) The method of claim [1] 10 including the step of:

using the etched substrate to fabricate one of a semiconductor chip, a magnetic head, and a flat panel display.

37. (Once Amended) The method of claim [1] 10 wherein:

said selecting step includes a hard mask comprised of at least one of a reactive metal and a compound of a reactive metal; and

 said selecting step further includes selecting a hard mask comprised of at least one of titanium, aluminum, tantalum, tungsten, cobalt, molybdenum, copper, nickel, iron, and compounds of at least one of titanium, aluminum, tantalum, tungsten, cobalt, molybdenum, copper, nickel, and iron.

38. (Once Amended) The method of claim [1] 10 wherein:

 said selecting step includes a hard mask comprised of at least one of a reactive metal and a compound of a reactive metal, and said compound comprises at least one of an oxide, a nitride, a fluoride, a boride, and a carbide of a reactive metal, and any combination of an oxide, a nitride, a fluoride, a boride, and a carbide of a reactive metal.

39. (Once Amended) The method of claim [1] 10 wherein:

 said selecting step includes a hard mask comprised of at least one of a reactive metal and a compound of a reactive metal, and said compound comprises any compounds formed by exposing a reactive metal to ions or radicals of at least one of oxygen, nitrogen, fluorine, boride, carbon, and any combination of said gases.

40. (Once Amended) The method of claim [1] 10 wherein:

 said selecting step includes a hard mask comprised of at least one of a reactive metal and a compound of a reactive metal; and

 said selecting step includes selecting a hard mask consisting of one of titanium, aluminum, tantalum, tungsten, cobalt, molybdenum, copper, iron, nickel, and compounds of one of titanium, aluminum, tantalum, tungsten, cobalt, molybdenum, copper, iron, and nickel.

42. (NEW) The method of claim 10 wherein:

said selecting step includes selecting a workpiece having a hard mask which hard mask comprises of one of titanium, aluminum, and tantalum.

43. (NEW) The method of claim 10 including the step of:
exposing the hard mask to a stream of oxidizing gas in the reactor prior to or during said etch step.
44. (NEW) The method of claim 10 including the step of:
exposing the hard mask to an oxidizing stream comprising of one of oxygen, nitrogen, fluorine, boron, and carbon gas, and any combination of oxygen, nitrogen, fluorine, boron, and carbon gas, in the reactor prior to or during said etch step.
45. (NEW) The method of claim 10 wherein:
said selecting step includes selecting a workpiece with a lithographic layer covering the hard mask.
46. (NEW) The method of claim 10 wherein:
said selecting step includes selecting a substrate having a hard mask which is readily oxidizable.
47. (NEW) The method of claim 10 wherein:
said selecting step includes selecting a substrate with a hard mark, which hard mask is comprised of a metal with a low sputtering yield.
48. (NEW) The method of claim 10 including the step of:
exposing the hard mask to a stream of oxidizing gas in the reactor prior to or during said etch step in order to oxidize the surface of the hard mask and thereby slow down an etch rate of the hard mask.

49. (NEW) The method of claim 10 wherein:

said selecting step includes selecting a hard mask (1) on which has been or (2) on which can be developed at least one of an oxide, nitride, fluoride, boride and carbide.